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Journal of the Society of Arts.

FRIDAY, APRIL 30, 1858.

EXAMINATIONS.

The following letter has been received, in reply to a request made by the Council to Lord Derby, that his Lordship would place at their disposal nominations to compete for Clerkships, and other Government situations of a similar character, as rewards to successful candidates at the Society's ensuing Examinations:—

Treasury, S.W., 28th April, 1858.

Sir,—Lord Derby has communicated to me the request of the Society of Arts, made through you, that a certain number of mominations to appointments under his Lordship's control may be placed at the disposal of the Society, and I beg to inform you that, in accordance with the wishes expressed by the Society, Lord Derby will be prepared to nominate four candidates during the present year, to compete for such clerkships and other similar situations as may fall to his Lordship's disposal.

I shall be obliged, therefore, if you will have the goodness to inform me, at your convenience, of the names and addresses of the four candidates whom the Society would desire to recommend, in order that their names may duly be recorded as desirous to compete for appointments.

I am, Sir,
Your obedient servant,
WM. G. HYLTON JOLLIFFE.

The Secretary of the Society of Arts.

THE SOCIETY'S CONVERSAZIONE AT THE SOUTH KENSINGTON MUSEUM.

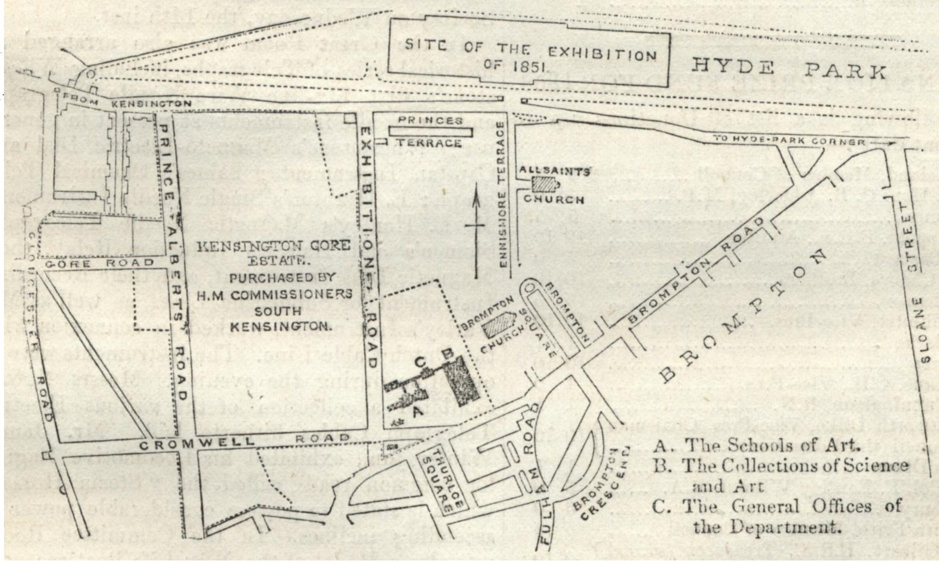
Members are requested to take notice that the next Conversazione will be held at the South Kensington Museum, on Saturday, the 8th of May. The doors will be opened at 8 o'clock.

The following divisions of the Museum will be lighted on this occasion:—

1. The Sheepshanks Gallery of Pictures.
2. The Sculpture Gallery.
3. The Architectural Museum.
4. The Animal Produce Collections.
5. The Ornamental Art Collections.
6. The Structure and Building Materials Collections.
7. The Educational Collections.
8. The Collection of Patented Inventions.
9. The Photographic Society's Exhibition.
10. The Art Training Schools.

Carriages are to set down at the refreshment entrance. The band of the Royal Horse Guards (Blue) will be in attendance.

The following plan shows the position of the new Museum at Kensington.



TENTH ANNUAL EXHIBITION OF INVENTIONS.

The Exhibition was opened on Monday, the 5th instant.

The Exhibition will remain open every day until further notice, from 10 a.m. to 4 p.m., and is free to members and their friends. Members, by ticket, or written order bearing their signature, may admit any number of persons. The number of visitors up to yesterday, the 29th inst., was 3,782.

LOCAL BOARDS—PREVIOUS EXAMINATION.

Fifty Local Boards have been formed. Returns of the Candidates who have passed the

Previous Examination have been received, as follows :—

Louth	4
Wigan	6
West Hartlepool	3
Leeds (Christian Institute). No. 1.	14
Northowram	1
Portsmouth	2
Warminster	1
Banbury	2
Macclesfield	23
Newcastle-on-Tyne	3
Lymington	1
West Brompton	4
Leeds, No. 2.	10
Wakefield	4
Pembroke Dock	4
Ipswich	6
London Mechanics' Institution	8
Manchester Mechanics' Institution	32
Selby	9
Bradford	18
Halifax, No. 1.	15
Salisbury	1
Sheffield	18
Liverpool	35
Lockwood	1
Halifax (Working Men's College), No. 2.	21
York	7
Berkhampstead	19
Bristol	11
London Domestic Mission	1
Royal Polytechnic Institution	28
Birmingham, No. 1, Messrs. Chance's Reading Room	2
Sheerness	1

EXAMINATION PRIZE FUND FOR 1858.

The following is a list of Donations up to the present date :—

T. D. Acland, Member of Council	£ 5	5
The Rt. Hon. C. B. Adderley, M.P.	5	0
John Ames	5	5
J. G. Appold, F.R.S., Auditor	10	10
T. H. Bastard	5	0
Messrs. Chance, Brothers	10	10
R. L. Chance	5	5
Harry Chester, Vice-Pres.	10	10
J. P. Clarke	1	1
G. Clowes	10	10
Henry Cole, C.B., Vice-Pres.	1	0
H. D. Cunningham, R.N.	1	1
C. Wentworth Dilke, Vice-Pres. Chairman of Council (third donation)	10	10
Thomas Dixon	1	1
Lieut.-Col. F. Eardley Wilmot, R.A.	5	0
Lord Ebury	5	0
J. Griffith Frith, Member of Council	5	5
J. W. Gilbart, F.R.S., Treasurer (second donation)	10	10
F. Seymour Haden (annual)	2	2
William Hawksworth	1	1
Edward Highton (annual)	£ 2	2
James Holmes (annual)	1	1
The Marquis of Lansdowne, Vice-Pres.	20	0
George Lowe, F.R.S.	1	1
The Master of the Mint, Member of Council (second donation)	10	10
George Moffatt, M.P., Vice-Pres.	10	10
Lieut.-General Sir Charles Pasley, K.C.B.	5	0
Sir Thomas Phillips, Member of Council	5	5
William T. Radford	1	1
Charles Ratcliff, Hon. Local Sec. (annual)	10	10
Joseph Skey, M.D.	1	0
William Tooke, F.R.S., Vice-Pres.	10	10
Arthur Trevelyan	1	0
T. Twining, jun., Vice-Pres.	10	10
Dr. J. Forbes Watson	1	1
G. F. Wilson, F.R.S., Member of Council (third donation)	10	10

CONVERSAZIONE.

The first Conversazione of the present Session was held on Saturday evening last, at the Society's House. The whole of the rooms were thrown open, and in the great room was displayed a series of upwards of sixty drawings of curious modes of marine propulsion, which had been prepared and were kindly lent by Mr. J. MacGregor.

In addition to the above, a collection of models, illustrative of the same subject, and patented between the years 1794 and 1850, were kindly lent by Mr. Brunet, the surviving partner of the late firm of Seaward and Co., and from the Museum of the Commissioners of Patents at Kensington. Mr. Tomkins kindly attended, and exhibited, by the aid of one of Ross's finest microscopes, the Infusorial Animalcules alluded to by Mr. MacGregor in his Paper "On the Paddle Wheel and Screw Propeller," read before the Society on Wednesday, the 14th inst.

In the Great Room was also arranged an historical series of Telegraphs, including Wheatstone's first Six-line Wire Needle Telegraph, and the needle instruments at present in general use; Wheatstone's Magneto-Electric Dial and Capstan Instruments; Baines's Chemical Telegraph; E. Highton's Single Needle Instrument; M. E. Henley's Magnetic Needle Telegraph; Siemen's and Halske's Induction Relay, their Magnetic Dial Instrument, and their Recording Instrument for Submarine Lines, as well as Mr. Varley's Instrument, worked in connexion with the Dutch Cable Line. The instruments were in operation during the evening. Messrs. Newall exhibited a collection of the various Electric Telegraph Cables hitherto laid. Mr. James Winter, jun., exhibited his Locomotive Engine for common roads, called the "Steam Horse," which is stated to possess considerable power of ascending inclines. In the Committee Room was also a Model of the New Life Boat recently adopted by the Shipwreck Institution, as well as a unique specimen of Double Refracting Iceland Spar, by Professor Tennant. The Exhibition of Patents in the lower rooms was thrown open.

The thanks of the Council are specially due to those gentlemen who kindly contributed their models and specimens on this occasion.

TWENTIETH ORDINARY MEETING.

Wednesday, April 28, 1858.

The Twentieth Ordinary Meeting of the One Hundred and Fourth Session was held on Wednesday, the 28th inst., Thomas Sopwith, Esq., M.A., F.R.S., in the chair.

The following Candidates were balloted for and duly elected members of the Society:—

Addis, William
Ashton, Thomas J.
Cormack, John Rose, M.D.
Lewis, John Frederick

The Paper read was—

ON THE PROGRESS AND PRESENT STATE OF BRITISH MINING.

By J. Arthur Phillips.

The metals sought by the miner usually occur in combination with either sulphur or oxygen, or their oxides may themselves be combined with an acid, giving rise to carbonates, phosphates, sulphates, &c. In this state they are said to be mineralised, and the unproductive substances with which they are associated are known as the matrix or gangue. When such a mixture contains a sufficient proportion of mineral to enable it to be advantageously treated, it is known as an ore of the metal which it contains.

Metalliferous ores are derived either from veins or beds, but gold, and the finer descriptions of oxide of tin, are chiefly obtained by washing certain alluvial deposits, consisting of the *débris* of veins yielding these metals.

Veins or lodes have been defined, by Werner, to be "mineralised repositories of a flat or tabular shape, which traverse strata, without regard to their stratification, having the appearance of rents formed in the rocks, and afterwards filled up with mineral matter, which differs, more or less, from the rocks themselves."

The most important ore occurring in beds is ironstone. This is frequently found interstratified with the coal, sandstones, and shales of the coal measures, and preponderates in value over every other mineral deposit worked in this country.

The methods of working these several forms of deposit, and the subsequent preparations of the ores obtained, have from time to time received various modifications and improvements, and these will form the chief subject of the present paper.

It would appear that silver and gold were known to the Britons before the Roman invasion, since coins of these metals were in circulation among them before the arrival of Cæsar. Cæsar and Strabo both state that the Britons obtained their copper from foreign countries, from which it may be inferred that the art of refining this metal was but little cultivated by our forefathers at that remote period. Iron is described by Cæsar as being so rare in Britain that pieces of it were employed as a medium of exchange; but, a century later, it had become exceedingly common, since in Strabo's time it was an article of exportation.

Tin was anciently, however, the most celebrated metallic product of Britain, and appears to have been obtained in considerable quantities, since it was the desire of obtaining possession of the tin mines, and thereby becoming independent of the Phœnician monopoly, which first induced the Romans to visit this island.

Before the conquest of their country, the ancient Britons extracted tin from its ores by methods which they had themselves discovered, and which were probably improved by their conquerors. The broken and rudely-washed ore was placed in a hole cut in the ground, the sides of which were lined with fuel, and this being ignited, reduced the metal, which was run off into an outer receptacle. Many of these rude furnaces have been discovered in various parts of Cornwall, in which not only charcoal and slags have been found, but also portions of reduced metal, which, in some instances, from long exposure to oxidising influences, have again become partially converted into peroxide.

The remains of these ancient establishments are known by the name of "Jew's Houses," and, a short time since, a remarkable relic of this description was found buried beneath a stratum of peat, twelve feet in thickness, at Redmoor, in the parish of Luxullian, Cornwall.

At this place, in addition to a considerable amount of metallic tin, more or less oxidised, on the exterior, large quantities of imperfectly fused scoriæ, mixed with imbedded charcoal and metallic globules, were discovered. A Romano-British fibula, some stone arrow-heads, a piece of bronze, a wooden shovel, and another shovel of wood tipped with iron, were also found, together with a fragment of an earthen "tuyere," and numerous blocks of peat, which had evidently been collected for the purpose of being employed as fuel by the ancient smelters, and had subsequently become covered by a deposit of the same material.

A large proportion of the objects found in this locality will be found lying on the table.

The form of bellows employed in these rude smelting works cannot now be determined, but two very simple methods of obtaining a current of air for such purposes are given in the diagrams on the walls of the room. The first of these represents bellows, from an Egyptian painting after Rosellini. The men are here represented as blowing a charcoal fire, to each side of which is applied a pair of bellows. These are worked by the feet, the operators standing upon and pressing them down alternately, whilst they pull up each exhausted skin by means of a string held in the hand. The second diagram represents the bellows employed for the manufacture of wootz, by the natives of India.

Another ancient smelting establishment, found in the same neighbourhood, was probably of a much more recent date, since not only were some portions of the stone-work still remaining, but the slags were more completely fused, and entirely free from any admixture of metallic globules. These slags, of which specimens will be found on the table, were found, on analysis, to have the following composition:—

Silica	40·60
Alumina	19·22
Oxide of tin	22·95
Protoxide of iron	7·31
Sulphide of iron	9·04
Lime	traces
Potash	1·00
	100·12

In this place there were also discovered some tobacco pipes and a coin of Charles I.

Previous to the time of Charles no attempt had been made to effect the smelting of tin by means of pit coal; but, at this period, some unsuccessful experiments were undertaken by Sir Beville Grenville, of Stow, in the county of Cornwall. No satisfactory results were, however, obtained until the second year of the reign of Queen Anne, when a Mr. Liddell, of Bodmin, who was associated with Mr. Moult, at that time celebrated as a chemist, obtained a patent for the reduction of tin ores in a blast furnace, by means of fossil fuel. The invention of the reverberatory furnace soon followed this discovery, and this apparatus, slightly modified in form and dimensions, is that employed by the tin smelters of the present day.

The alluvial tin deposits of Cornwall have been worked from the remotest antiquity; but during the last three centuries the larger proportion of ore produced has been derived from workings on lodes.

The produce of these, in 1800, was 2,522 tons; in 1810, 2,036 tons; in 1820, 2,990 tons; in 1830, 4,444 tons; and in 1855, 6,000 tons of black tin. Tin ore, or black tin, usually contains about 70 per cent. of metal.

One of the oldest mines in Europe, producing large quantities of copper, is that of Rammelsberg, near Goslar, in Lower Saxony, the records of which have been traced back to the tenth century. The celebrated Swedish mine of Fahlun, commenced in the twelfth century, afterwards entered into competition with Rammelsberg, and afforded large quantities of ore. The mines of Thuringia were opened in the thirteenth century, and, together with others of less note, situated in various parts of Germany and Sweden, supplied for some years the wants of a large portion of the civilised world.

Cumberland is known to have produced copper in the thirteenth century, as it is shown, by records still preserved, that rich veins of this ore were worked at Newlands, near Keswick, in the year 1250. It is also evident, from a charter granted by Edward IV., A.D. 1470, to the town of Keswick, that it was at that period the seat of extensive copper works. In Camden's time these works were re-opened, but afterwards destroyed, and the miners killed in the civil wars.

Copper was also produced in considerable quantities at Ecton Hill, in Staffordshire, before its discovery in Cornwall, since Dr. Pot, who wrote in 1686, speaks of the copper mines as having been wrought long previous to that date.

The Pary's mine, in Anglesea, is supposed to have been first opened by the Romans, and became exceedingly productive about the year 1773; and, during the twelve succeeding years, produced such large quantities of copper ore as to reduce, in a very considerable degree, the price of that metal throughout Europe. Subsequently to this date the produce of the Anglesea mines began rapidly to decline, and, in 1799, the Pary's mountain had become almost exhausted.

Systematic explorations for copper were probably commenced in Cornwall about the year 1700. At first the annual amount of ore raised was very limited, as several causes operated to restrict this branch of industry.

The machinery employed was inefficient, and unfitted for removing large quantities of water from considerable depths. The royalties, or lord's dues, were also usually exorbitant, amounting to one-eighth, one-seventh, and even one-sixth of the gross produce of the mine, whilst the smelters, on the other hand, compelled the miners to accept such prices for their ores as they thought fit to determine. With the improvement of pumping machinery and a more liberal scale of royalties, the annual production of copper ores in Cornwall has now reached nearly 200,000 tons, and there is but little doubt that the yearly produce of this metal will steadily increase. The average yield of Cornish copper ores may be taken at about 6¾ per cent.

A work entitled "A Just and True Remonstrance of His Majesties Mines Royall to His Majestie," published in 1641, affords a tolerable idea of the state of lead mining in this country at that period. This volume consists of a series of letters, or rather memorials, addressed to the King (Charles I.), the Prince of Wales (afterwards Charles II.), and the Privy Council, by Mr. Bushell and others, interested in the "mines royall" of Cardiganshire, praying for the extension of the lease, the employment of convicts in the mines, and the liberty of cutting peat and turf for the purpose of smelting the ores.

Sir John Pettus, who published his "Fodinæ Regales" in 1670, remarks, while treating on the mines of Cardiganshire, "The chief mines which produce silver now in working (though not effectually), are those at Coomsumblock and the Darren Hills, Cogincan, Tallabont, Coomustwith, Tredole, Thruscott and Rossovawre, which were the old Roman works, near to which are conveniently placed the smelting and refining mills, all which are in the townships of Skibery Coed, in the parish of Llanny Hangell, Genne Glyme, and in the County of Cardigan, *alias* Shire Abertivy."

The ores furnishing lead are more uniformly distributed in this country than those of copper. About 330 lead mines are now making returns, and at least 400 may be estimated to be in operation, although the total produce of this metal has, of late years, experienced but slight increase. A large quantity of British lead ore contains a valuable amount of silver. The richest ores are produced in Cornwall, and yield, on an average, about 23 ozs. of silver per ton. The mines of Alston Moor, Weardale, and Teesdale, afford lead yielding from 6 to 12 ozs. of silver per ton, Derbyshire and Shropshire lead contains from 1 to 1½ oz. per ton, and the mines of Flintshire and Denbighshire yield lead averaging from 4½ to 6½ ozs.

The nett consumption of pig lead in our home manufactories, for eight years ending 1855, averaged nearly 55,000 tons per annum. The price of this metal has experienced great fluctuation during the present century. From 1806 to 1815, it averaged £27 12s. per ton; from 1816 to 1825, £21 18s. 6d.; in 1830, the price had declined to £12 10s; whilst, at the present time, it may be taken at £22 10s. In 1796, the make of iron in this country amounted to 125,000 tons; in 1806, to 250,000 tons; in 1820, to 400,000; in 1827, to 700,000; and in 1855, to nearly 3,300,000.

Coal was not generally employed as fuel until the beginning of the reign of Charles I. It is, however, mentioned in documents anterior to the reign of Henry III., for that monarch, in the year 1234, renewed a charter granted by his father to the inhabitants of Newcastle, who were permitted to dig for coal on paying an annual tax of £100. That this fuel had been introduced into London before 1306 is proved by the fact that in that year its use was prohibited from the supposed tendency of its smoke to "corrupt" the atmosphere.

The coal-fields of Colliery, near Lanchester, were first opened in the year 1330; those at Merrington and Ferry Hill, in 1343, and those of Gateshead, Wickham, and Tynemouth, in the year 1500. The coal-fields of the United Kingdom have been estimated to contain an area of 12,000 square miles. The present vend of coal is about 5,500,000 tons per month. This is obtained from 2,700 collieries.

The annual yield of our mineral products now amounts to £35,000,000, and any estimate of the value which this sum ultimately assumes after the metals have been subjected to more or less complicated elaboration, must be merely hypothetical.

Mining Operations.

Sett, &c.—It being impossible to compress within the limits of a single paper even a very brief sketch of all the various systems of mining resorted to in this country, I shall confine my observations to the method employed for the working of mineral veins, and endeavour succinctly to trace the operations of the miner from the time of selecting a piece of ground for exploration up to the period of his forwarding his dressed ores to market. Whilst doing this, I shall also point out some of the more striking improvements which have been introduced, and direct attention to the direction from which further advantages may be anticipated.

The minerals of Great Britain do not, as in many continental countries, belong solely to the crown, but are generally the property of private individuals. The mineral and surface rights are, moreover, not always united, and, consequently, the mineral lord may be in receipt of an income from mining operations, whilst the surface proprietor, whose land is destroyed, receives little or no compensation.

In most of our mining districts the veins cannot be explored without the express consent of the proprietor, but in certain exceptional localities they may be attacked without any special license or authorisation. In such cases tradition and custom constitute the acting covenants, and necessitate each individual miner to become a conservator of the general privileges.

The consideration given for the right of exploring the contents of a vein is usually a fixed proportion of the value produced, rendered either in kind or money, and technically known as royalty. This is secured to the lessor by a lease, which embraces a variety of covenants with the lessee relative to the management of the property, and which remains in force during a stated number of years.

The operations of the lessee are confined within certain specified limits, called a Sett, within which, subject to various restrictions, he may work as he thinks proper. Previous to obtaining a lease, the miner sometimes works under what is called a take-note, extending over a period of one or more years. This document is more simple than a lease, and its cost comparatively trifling.

Shoding.—When a piece of ground has been selected, and a take-note or lease been obtained, the operations of the miner are usually commenced by what is known as shoding or costeaning. This consists in sinking a series of pits from the surface to a short distance in the shelf or rock, in a direction as nearly as possible at right angles to the presumed run of the lodes in the locality. These pits, being connected with each other by means of galleries from their bottoms, will necessarily discover the backs of any veins or lodes that may be traversing the property.

When sufficient inducement for the further prosecution of the work has been discovered, the ground is either explored by an adit-level, or by shafts, crosscuts, and levels.

An Adit Level consists of a gallery driven in from the lowest available ground within the limits of the sett, and may be either directed on the course of one of the principal lodes, or so as to intersect the different veins at a more or less considerable angle. The first method, where practicable, possesses the advantage of exploring a considerable length of the vein, on the direction of which the level has been extended, and affords facilities for intersecting a number of parallel lodes by means of cross cuts, whilst, by the second, the whole of the veins contained in the sett may be frequently intersected.

A large amount of both money and time, are, however, often squandered in resorting to drainage by means of an adit level. Whatever facilities the locality may afford for this system of drainage, it is never prudent to resort to it if its cost will much exceed that required for the erection and maintenance of machinery to secure the same object. For this reason long shallow adits, a few fathoms only below the surface, are seldom to be recommended, since, to explore the ground to any considerable depth, machinery must generally be erected, and when this is done, the cost of raising water an additional ten or fifteen fathoms is but trifling. An adit level usually affords drainage to a very limited extent, and possesses few advantages beyond saving the cost of raising water from its point of intersection with the lode to the line of surface. When once this depth, and the quantity of water are known, the cost of the necessary machinery, and the expense of pumping can be approximately determined, and if these be compared with the expenditure incident to the driving of a level, the relative advantages of the two systems in both time and money become apparent.

Shafts.—When the employment of shafts has been determined on, it is of the greatest importance to the success of an undertaking to choose eligible sites for these works, since they not only constitute the highways to and from the various horizontal galleries, but also afford the necessary facilities for unwatering the mine, and removing its produce. Where extensive permanent operations are contemplated, vertical shafts are generally to be preferred, especially when large lifts of pumps are to be placed in them, but in the case of commencing preliminary trials, it often becomes a question worthy of careful consideration, whether a saving of both time and money may not be effected by the use of underlie sinkings. Apart from ventilation and pumping, shafts are only used for winding and climbing, and for the latter purpose inclined are preferable to vertical shafts. The drawing of stuff through inclined shafts was formerly attended with considerable inconvenience and expense, since no efficient means had been adopted for the prevention of friction and strain. These evils have of late years been obviated by the introduction of a kind of guide rail from the mouth to the bottom of the shaft. This may be constructed either of wood or iron, whilst the kibble should be not only provided with wheels to run on the rails, but should also have anti-friction rollers, so arranged as to retain it in its proper position during its passage through the shaft. The form of the kibble employed should be such as to admit of its being readily filled and emptied. Where these appliances are adopted, the cost of drawing through underlie shafts is not found to exceed that of hauling through vertical ones, whilst in many instances the difference of the cost of sinking is exceedingly great.

Levels on the Courses of Lodes.—Pryce, who wrote his "Mineralogia Cornubiensis," in the year 1778, states, that at that period the vertical distance between levels averaged about eight fathoms, but since that time it has been increased to ten, and, in some instances, twelve fathoms. There does not, however, appear to be any valid reason for adopting uniformity of distance between such drivages, since this should rather depend on the nature and character of the lode than on any arbitrary custom. When lodes are large and contain short lenticular bunches of ore, as in the case of many of the German mines, a less distance than ten fathoms may be advantageous, but in the case of veins presenting considerable uniformity of composition, distances of even fifteen fathoms might sometimes be adopted with advantage. The drivage of levels at short distances from each other must necessarily entail a heavy expense on an undertaking, and, consequently, this portion of mining cost should be carefully economised.

Winzes and Stopes.—Winzes are shafts sunk between two levels for the purpose of connecting them, but without communicating with the surface, and are employed for forwarding ventilation, and many other purposes. When a shaft is sunk or a gallery excavated in hard rock, there is but little difficulty in making it retain its original form, but should the ground be soft, and consequently offer but little resistance to pressure, artificial means must be adopted for its support. This is most frequently effected by means of wood, although, in some instances, walls of brick or stone are employed for that purpose.

The ores existing in a vein are, to a certain extent, extracted in cutting the longitudinal galleries excavated in it, but, as these are situated at considerable distances from each other, the ore thus raised forms but a very inconsiderable part of the produce of the lode. In order, therefore, to obtain the minerals between the different levels, the ore is worked out and the space afterwards filled in with rubbish arising from the other operations of the mine. This operation is called stoping.

Methods of Attacking the Rock.—The tools employed by the miner necessarily vary in accordance with the nature of the rock which he has to traverse. If the ground be soft, nothing but an ordinary pick and shovel is employed; if it be somewhat hard, and contain numerous fissures, he has recourse to the use of steel wedges, called "gads," by driving which into the crevices of the rock he is enabled to split off larger portions than he could by the use of the pick alone. When the ground to be cut through does not admit of being thus broken, the work is effected by the assistance of gunpowder.

Before this can be employed, it is necessary to bore a hole into the rock for its reception, which is done by means of a bar of steel, armed with cutting edges. Instead of using a steel bar, one of iron, furnished, at one of its extremities, with a steel point, is sometimes employed. To use this instrument, one of the workmen holds the sharpened end of the borer to the rock, whilst another hits the other end a heavy blow with a large hammer or a mallet. As the hole deepens, the person who holds the tool turns it a portion of a revolution between each blow, and in this way a deep hole is ultimately obtained. The borer is, from time to time, during the operation, removed from the hole for the purpose of taking away the broken rock or sludge, and a little water is added for the double purpose of cooling the borer and facilitating its action. When the hole has attained a sufficient depth, which necessarily varies with the nature of the rock operated on, it is carefully cleaned out with what is called a swab-stick, and a proper quantity of gunpowder deposited at the bottom. For the purpose of confining this, and thereby giving force to the explosion, the hole is now filled up by ramming in a quantity of soft schist called "tamping;" a small hole being left by the introduction of a copper needle, which is subsequently removed to afford means for exploding the charge when required. This is done by means of a reed or rush, filled with fine powder, and to which a slow match is attached, during the burning of which the men have time to escape out of the reach of the fragments of rock projected by the explosion. Within the last few years, however, this method of blasting has, in this country, become almost entirely superseded by the use of the "patent safety fuse," which itself not only acts as a slow match, but has also the advantage of being safer and more readily employed, since, with it, the copper needle is no longer necessary, the fuse being placed in the hole before it is closed, and the tamping forced in around it.

When the rock in which a hole has been bored is damp from infiltration of water, the powder is enclosed in a waterproof bag before being introduced into the cavity.

Pumping Machinery.

From the large quantities of moisture constantly percolating through the strata, all the workings of a mine below the adit level would quickly become filled with water if some means were not adopted for its removal, and, for this purpose, numerous and frequently very complicated machinery has, at various periods, been made use of.

The most simple and earliest employed method of removing the water from a shaft, is doubtless by means of a bucket and cord set in motion by manual labour or horse-power. although, on referring to the works of Agricola, who wrote about the year 1530. we find that pumps of various descriptions, set in motion by water-power, were then in very common use for mining purposes.

We are informed by Mr. Bald, in his "Coal trade of Scotland," published in 1812, that in 1890 water-wheels and chains of buckets were commonly employed to drain the collieries in that country. The axle of the wheel extended across the pit's mouth, and small carriers were fixed upon it to receive endless chains, consisting of two or three tiers which reached down to the coal. To these chains were attached wooden buckets or troughs fixed in a horizontal position, which circulated with the chains ascending on one side and descending on the other, filling at the bottom and discharging at the top, as they turned over the wheels of the axletree. This apparatus was subject to the inconvenience, that whenever a joint gave way, the whole set of chains fell to the bottom, and every bucket attached to them was splintered in pieces by the fall. When water could not be procured, the same sort of machinery, upon a smaller scale, was worked by horses.

In 1708, windmills were erected to work pumps on several collieries in Scotland, but, being ineffective in calm weather, never came into general use. Savery, about the year 1696, was probably the first to employ steam-power for the raising of water to a higher level.

In Savery's engine, a vacuum was formed in the receiver by the condensation of steam; water was then forced into it by the pressure of the atmosphere, and elevated to any required height by the direct action of steam on its surface. This inventor was the first to employ the term horse-power. His apparatus was ultimately superseded by Newcomen's atmospheric engine, introduced about the year 1705. The construction of this machine differed widely from Savery's arrangements, inasmuch as the steam exerted no direct influence on the surface of the water to be elevated, but was only employed as a means of forming a partial vacuum beneath a piston attached to one end of a lever, whilst the pump rod was in connection with the other. In this way atmospheric air performed the principal duty, whilst steam was merely used as a means of removing the air from beneath the piston. To this engineer belongs the credit of introducing the beam or balance lever and the method of condensing steam, and forming a vacuum by immediate contact with cold water.

The various cocks and valves of this apparatus were at first opened and closed by the hand of an attendant, until Humphrey Potter ingeniously connected them with the beam by means of strings and catches. This arrangement was subsequently improved on by Mr. Henry Beighton, who employed the plug rod and hand-gear; which, with but slight modification, is that used at the present day. This gentleman was also the first to adopt the steelyard safety-valve.

Two of Newcomen's engines were, at an early period, erected at Wheal Busy, near Chacewater, with cylinders respectively 66 and 72 inches in diameter. The consumption of coals by these two machines amounted to 320 bushels, or about 13 tons daily.

In the year 1766, the attention of Smeaton was first directed to improvements in steam machinery. With an experimental engine of one-horse power, he evaporated 6¼ lbs. of water by 1 lb. of coal, and produced the best effects with a pressure of 8 lbs. above that of the atmosphere. In 1775, he erected a 72-inch atmospheric engine at Wheal Busy. The stroke of this machine was 10½ feet, the cylinder being placed over the boiler, and the main-beam composed of several pieces of wood bolted together, and provided with **D** ends. The highest duty performed by this apparatus was 9,450,000. By enclosing the fire, and supplying the fuel through a tube, this engineer was able to evaporate 7.88 lbs. of water with 1 lb. of coal. Watt was chiefly occupied with his improvements of the steam engine from the year 1762 to 1800. He found that the loss of heat, arising from condensation within the cylinder, amounted to 32 per cent. of that employed, in addition to a considerable loss of time to effect the result.

His first attempt at improvement was to employ a wooden cylinder; but he ultimately arrived at the conclusion that, in order to obtain the greatest economic effect of steam, the cylinder should be of as high a temperature as the vapour entering it—that condensation should be effected in a separate vessel—and the injected water, if possible, cooled to below 100 deg. Fahr.

The means of accomplishing this did not occur to him until 1765, when he conceived the idea that, if a communication were opened between a cylinder containing steam and another vessel exhausted of air, the steam, as an expansive fluid, would immediately rush into the empty vessel, and continue to do so so until an equilibrium was established; and that if the vessel were kept sufficiently cool, by injection of water or otherwise, more steam would continue to enter, until the whole was condensed.

Thus, the production of a vacuum in the cylinder, without cooling it, was insured, and the principle of the steam engine became what it continues to be at the present day. In addition to the condenser, Watt employed a method of lubricating the piston by the employment of wax or tallow; placed an air-tight cover on the cylinder, with a stuffing-box round the piston rod, and so admitted the steam above the piston as to act on it in place of atmospheric pressure. The separate condenser was patented by Watt in 1769; and in 1776, he succeeded in obtaining a duty of 21,000,000 from an engine erected at Soho. In the year 1784, he patented the arrangement of levers known as the parallel motion, and applied the governor for regulating the motion of the engine. He likewise, about this period, introduced the system of admitting steam alternately on either side of the piston, thus making the engine double instead of single-acting.

In granting licenses for the use of his inventions, Watt stipulated that he should receive one-third part of the value of the saving of coal effected by his engines as compared with atmospheric machines doing the same work with similar fuel. In order to obtain a standard of comparison for this purpose, a committee was appointed in 1778 to make a trial of two atmospheric engines, at Poldice, in Gwennap, and reported their duty at 7,058,252, which was from that time taken as the standard of Newcomen's engines. The number of strokes made by the several machines was ascertained by means of a train of wheels, called "a counter," attached to the vibrating beam.

The practical application of the expansive property of steam was first suggested by Watt, in 1769; introduced by him, at Soho, in 1776; and, in the following year, at some water-works near London. In 1781, Hornblower took out a patent for working steam expansively, and may be considered to have been the first to bring this subject prominently before the public. He was also the first to employ two cylinders, since known as the combined cylinder engine.

Watt employed what is called low-pressure expansive steam, but, in 1802, Trevithick and Vivian obtained letters-patent, securing the application of high-pressure principles to the steam-engine. In 1806 one of those engines was used at Dolcoath mine for drawing ores, and about this period the idea occurred to Trevithick to employ high-pressure steam in Bolton and Watt's engine, and expanding it down to the density at which it is usually admitted. This method was not, however, adopted till 1812, when it was tried at Wheal Prosper. In this engine the steam was cut off at one-tenth of the stroke, and the pressure in the boiler was 40 lbs. to the square inch. Woolf, in 1810, introduced high-pressure steam in a small cylinder, which was subsequently expanded in a larger one of four times the capacity, and by this means obtained a duty of 34,000,000, which, in May 1816, was increased to 57,000,000. In 1815 Trevithick patented his pole engine, and erected one of them at the Herland mines. Mr. Sims, by combining Trevithick's pole with Bolton and Watt's engine, realised, in 1817, a duty of 49,900,000, from an engine at Wheal Chance. Several machines of this description were erected in different parts of Cornwall about this time, but were ultimately abandoned, and superseded by single-acting engines, in which the steam was worked at a higher pressure, and more expansively than had been hitherto done. Captain Grose, in 1825, erected an engine at Wheal Hope, which, by a judicious system of clothing, yielded a duty of 62,000,000, which, in 1828 he augmented to 87,000,000, in an engine erected at Wheal Towan.

The following table, compiled by Mr. Enys, contains various interesting particulars connected with the engines of Newcomen and Watt:—

Engines.	Newcomen's.	Watt's low-pressure (often expansive).	Watt's high-pressure expansive.
Largest cylinder in inches...	77	63 double	90 single
Load in pounds per square inch	6 to 7½	6 to 9	3 to 18
Period of use	1,720 to 1,778	1,778 to 1,812	1,812 to 1,836
Highest duty in million pounds	3 to 7	12 to 9	20 to 93
Average duty in million pounds		19½ in 1.793 17½ in 1,798	about 50
Depth of mines in fathoms	90	200	293

In 1835, Messrs. Lean estimated the number of pumping engines in Cornwall at 104; stamping engines, 14; and winding engines, 66; making a total of 184. These annually consumed 69,559 tons of coal, of the total value of £59,125. The quantity of water delivered from the Cornish mines in 1837, was estimated by Sir Charles Lemon at 37,000,000 tons. The average cost of pumping water in the Cornish mines, from a mean depth of 100 fathoms, is about 1 3-10th penny per 1,000 gallons. This sum includes coal, engine men, and pitmen's wages and sundries, but does not comprehend any charge for wear and redemption of machinery.

Duty of the Steam-Engine.—The term duty was first employed by Watt to express the net result obtained from the combustion of a given quantity of coal. This expression may therefore be regarded as the result obtained by multiplying the weight of water lifted by the space through which it has been raised, and dividing by the weight of coal consumed—$\left(\frac{W \times S}{C}\right) \doteq X$.

Messrs. Boulton and Watt appealed to this test of the efficiency of their engines, when engaged in determining the saving of fuel due to their inventions. Watt also invented the *counter*, for recording the number of strokes made by an engine; this was, as at the present time, attached to the main-beam. At the expiration of Watt's patent, about the year 1800, the duty of the best engine in operation was 20,000,000, which, compared with the best results rendered by Smeaton's engines, viz., 9,450,000, will show an increase of 100 per cent., and this may be taken as the economic value of the several improvements effected by this inventor.

The progressive duty of the steam-engine has been ably traced by Mr. Taylor, from the time of Smeaton down to the year 1828. The researches of this gentleman show that practical experience has done far more than scientific investigation towards attaining the present great economy of fuel; and that this result has been mainly effected by the use of high-pressure steam expansively employed, introducing Trevithick's boiler, and clothing the cylinder and steam-pipes with some non-conducting material.

The periodical increase of duty in Cornish steam-engines from 1813 to 1856 is given in the following table:—

Year.	Approximate No. of engines reported.	Average duty of the whole.	Average duty of the best Engine.
1813	24	19,456,000	26,400,000
1823	45	28,156,162	42,122,000
1833	57	46,142,466	83,306,000
1838	61	48,700,000	84,200,000
1843	36	60,000,000	96,100,000
1848	27	53,166,600	——
1856	24	47,000,000	——

Of late years the duty of the Cornish steam-engine appears to be slightly on the decrease, but this is in some measure due to the employment of fuel of an inferior description. In the year 1838, the Messrs. Lean reported the average duty of 61 pumping-engines as amounting to 48,700,000 lbs. of water raised one foot high by the consumption of 94 lbs of coal, and, in the year 1856, Mr. Thomas Lean reports 24 engines as having consumed 19,578 tons of coal, which raised 160,000,000 tons of water 10 fathoms high, or 56,000,000 tons lifted 1 foot high by 112 lbs. of fuel, which is equal to 47,000,000 lbs. raised through the same space by the expenditure of 94 lbs. of coal. This shows a decrease during eighteen years of 1,700,000 lbs. per bushel of coal consumed.

Mr. Browne, who, in 1856, reported on 22 pumping engines, gives an average duty of 35,500,000 lbs. of water raised 1 foot high by 112 lbs. of coal, but his system of reporting being dissimilar to that of Mr. Lean, the relation between the two results is not readily apparent.

It has been before observed that no marked improvement in the duty of the Cornish engine has been effected for many years, and it may be remarked that but little increase in the economic performance of this machine can be anticipated until steam of higher pressure and expanded to a corresponding degree be employed. In order to accomplish this object, a longer cylinder might, perhaps, be advisable, whilst such modifications could at the same time be introduced in the valve gearing, and the mode of admitting steam on the piston, as should, in a great measure, avoid impact, and, at the same time, afford the advantages due to high tension.

This idea is, to a certain extent, gaining ground among Cornish engineers, since one of them has proposed to lengthen the cylinder and do away with the parallel motion by running the piston rod in guides. He also suggests fixing the steam valve on the cylinder cover, and the equilibrium in the piston. Whether these propositions are in accordance with increased economy, experiment alone can determine.

Water Pressure Engines.—In localities in which a high fall of water can be procured, the water-pressure engine may frequently be employed with advantage. In this machine the power is obtained by means of a descending column of water acting by its weight on a piston working in a closed cylinder. The credit of inventing this machine appears to belong to Hungary; but various Saxon engineers have also devoted considerable attention to the improvement of this apparatus, and have succeeded in bringing it to a great degree of perfection. The first pressure engine in this country was constructed under the superintendence of Mr. Westgarth, in the year 1765. Smeaton afterwards modified and improved Westgarth's machine in an engine which he constructed in Yorkshire. Trevithick also devoted a considerable amount of attention to these engines, and has since been followed by Dean Armstrong and Darlington. The pressure engine may be either single or double acting. In the former case the piston is moved in one direction by the pressure of a column of water, and returns to its original position by the action of a counterpoise weight, whilst in the latter the piston is alternately acted upon on either side by hydraulic pressure.

The admission and discharge of water from the cylinder is effected by cocks, valves, or pistons, acted on by proper plug gearing, but for large engines piston valves are preferable, as being less liable to derangement. One of the most powerful single-acting hydraulic pumping engines erected in this county, was designed in the year 1842, by Mr. Darlington, for the Alport mines in Derbyshire. The principal dimensions of this machine were as follows:—Diameter of cylinder 50 inches; stroke 10 feet; plunger pole 42 inches in diameter; pressure column 132 feet in height; length of plunger lift 140 feet. The total pressure in this case was 50 tons or 58 lbs. per square inch, and the power employed equal to one hundred and sixty-eight horses.

The cylinder stands on two cast-iron bearers fixed across the shaft; the piston-rod works through the cylinder bottom, and is a continuation of the main rod working the pumps. In front of the main cylinder is a smaller one, with differential diameters, for the admission and emission of water, and right and left are sluice-cocks for regulating the speed of the engine; connected with the feed-cylinder is a third, of still smaller dimensions, provided with regulating cocks.

In starting this engine the sluice-valves and regulating-cocks are opened, and the water from the pressure-column flows into the cylinder, acting upon the piston, until the upstroke is completed. The feed-piston is connected with another of larger diameter, and when relieved from pressure on its upper surface, the water acting between them forces it upwards, by which movement the pressure from the main column is cut off, and the water contained in the cylinder becomes free to escape through apertures prepared for that purpose. With the emission of the water the down-stroke of the engine is effected. The downward motion of the feed-piston is obtained by the auxiliary cylinder and piston, the pressure of water continually acting between them, and by their displacement by the fall-bob and canti-lever on the arbor, the water is either admitted or cut off from the upper piston of the feed-cylinder. The motion of the canti-lever is produced by plugs on the main rod acting on a horn.

Pit Work.—The pumps employed for the drainage of mines were formerly made of wood, but are now almost universally constructed of cast-iron, and vary in diameter in accordance with the work they have to perform. Pumps are, however, seldom less than four inches, and not frequently above 24 inches, in diameter. The pit work of a mine usually consists of a series of pumps, delivering their water into cisterns, placed on bearers thrown across the shaft, in which are placed the windbores or lower extremities of the lifts next in succession. Both drawing and force pumps are employed for this purpose, but the bottom lift is generally a drawing pump, and those placed above it force pumps, or plungers. The drawing lift very closely resembles the ordinary pump employed for domestic purposes. One of the diagrams on the walls represents a plunger pump 42 inches in diameter, erected by Mr. Darlington, at the Alport Mines, in 1841.

Hauling.—In order to remove the produce of a mine to the surface, buckets, called kibbles, made either of wood or sheet iron, are employed. The size of these necessarily varies with the nature of the power to be used for lifting them. Until a shaft has reached a depth of ten fathoms, the only lifting apparatus generally employed consists of a windlass or tackle worked by manual labour. The kibbles and their ropes are, in most instances, arranged in such a way as to pass each other in the shaft, so that whilst one bucket is coming up the other is descending. When the shaft has been sunk beyond this depth, greater power is required, and horses, water, or steam are resorted to in order to obtain the required motive force. When horses are used, the machine employed is called a "whim," and is simply a large windlass, placed vertically, and fixed in the neighbourhood of the shaft. This machine consists of an upright axle, turning in a socket at its lower extremity, and at the upper end working in a bearing supported by a heavy horizontal beam. Around the upper portion of this axletree is constructed a cage or drum, around which is wound the rope to which the kibbles are attached. The arrangement is also provided with a long horizontal arm to which the horses are attached, and in order to convert the horizontal motion of the ropes round the drum into a vertical motion in the shaft, they are passed over pulleys set in a wooden framework called the "poppet-heads" or "shaft-tackle," erected over the mouth of the shaft. Steam is seldom employed for hauling from shafts less than from 40 to 50 fathoms in depth, and an engine is not often put up until after the value of the mine has been somewhat established.

In Cornwall the low-pressure engine is generally preferred, but in other localities small horizontal high-pressure engines are often employed. The machinery used in Cornwall for this purpose is more expensive than that employed in collieries, whilst the speed of the rope is not only less, but the weight at a draught is, on the whole, not so considerable. The monthly engine reports of Mr. Browne, show that for the year 1854, twelve engines raised 35,833 kibbles from a mean depth of 139 fathoms, and that the average duty of these machines amounted to about 15,500,000 lbs. raised one foot high by the combustion of 112 lbs. of coal. Most of the Cornish winding engines have been designed with a view to the utmost economy of fuel; but it is to be doubted if the engineer always succeeds in this way in effecting a real saving of expenditure, since it must be recollected that an economy of fuel, extending over a very long period, will be required to compensate for the difference of first cost and the resulting interest on outlay.

The difference of expense between hauling by steam and horse-power has been estimated at 50 per cent. in favour of the former; but this is certainly less than the true result, and in deep mines it would be found all but impossible to remove the stuff broken by horses alone. The annexed table affords some interesting particulars relative to drawing engines employed for mining purposes.

Mechanical Preparation of Ores.

Picking.—The ores which are extracted from the mine are not usually sufficiently rich in mineral to enable them to be smelted without being first subjected to sundry mechanical operations. As they are but sparingly diffused through the lode, and are mixed with large quantities of unproductive stone, a preliminary sorting takes place in the mine itself. The miner separates those fragments which do not appear to contain any portion of metallic matter from those which have a certain proportion of ore diffused through their substance; the former being allowed to remain in the mine, where they are employed for filling up certain portions of the excavations, whilst the latter are transported, by means of either barrows or waggons, to the shaft, and subsequently conveyed to the surface. They are now generally washed under a stream of water falling on a coarse grating or perforated iron plate, and divided into at least three classes, 1st, the gangue, or stony matter, which is rejected; 2nd, the rich ore, or best work, which, in the case of copper or lead ores, is frequently sent direct to market; and 3rd, the fragments, which, although containing but a small quantity of mineral, are, nevertheless, too valuable to be thrown away.

Crushing and Stamping.—Before the ores so prepared can be further concentrated, they must be first reduced to the proper degree of fineness, and are, for this purpose, subjected to the action either of a crushing or stamping mill.

The crushing mill consists of two strong iron rollers, set in motion either by steam or water-power, working in a framework of cast-iron, firmly secured by screw-bolts to heavy wooden bearers. The bearings of these rollers are so arranged as to slide in grooves, and consequently admit of the cylinders being either advanced or separated to a greater distance. To prevent accidents to the machine from the passage of large fragments of stone too hard to be broken, a certain degree of elasticity is given to the arrangement by means of levers, which by a sliding bar and shoulder constantly tend to keep the surfaces of the two grinding cylinders in contact, since the other extremity is loaded with an iron box containing heavy weights. The ore to be crushed is allowed to fall gradually between the two rollers through a hopper, the weight on the levers being so adjusted as to suit the degree of hardness of the mineral to be broken. On passing through the rollers, the crushed ores fall into the upper extremity of an inclined cylinder of coarse wire gauze. This being set in motion by the same machinery as the rollers them-

Name.	Character of Engine.	Diameter of Cylinder.	Length of Stroke.	Number of revolutions per minute.	Speed of Piston in feet per minute.	Pressure of steam on Piston per square inch.	Mean Diameter of Drums.	Speed of rope in Shaft per minute.	Weight of Load drawn.	Tons drawn per day of eight hours.	Depth of Pit or Shafts.	Diameter of drawing Pulley.	Remarks.
		in.	ft. in.		ft.	lbs.	ft.	ft.	cwt.		yards.	ft.	
South Sea Colliery...........	Vertical Spur gearing	20½	4 6	60	450	40	10 & 8	945 & 750	20	250	130 & 165	7	
British Iron Works	Horizontal direct link motion.	24	4 6	35 to 50	315 to 450	50	11 & 11	1400	20	400	160	8	
Bryn Malley Colliery..................	”	26	5 0	40 to 50	400 to 500	45	9 & 11½	1130 & 1440	20	400	140 & 210	7	
Minera Lead Mine, No. 1.	” Spur gear	14½	3 0	50	300	14	5	250	26	100	120 150 170	7	
” ” No. 2.	” ”	14½	3 0	50	300	15	4½	250	25	100	100	4½	200 Tons if from 2 Pits.
Average of Mines of Cornwall...........	Vertical condensing	22	5 0	15 to 20	150 to 200	12	4½	150	10	...	Variable	5	

selves, divides the pulverised ore into two classes, the one passing through the meshes of the trellis, and falling into a suitable receptacle placed beneath it for that purpose, whilst the other, which is too large to pass through the apertures, is carried to the lower end of the cylinder, where it falls into the buckets of a kind of inverted water-wheel, by which it is again carried to the level of the rollers for the purpose of being re-crushed. The average expense of crushing copper ores by water-power may be taken at 2½d. per ton.

The poorer varieties of ores, and especially those of tin, instead of being crushed by rollers as above described, are pounded into small fragments by means of heavy pestles, set in motion either by water or steam power. The machinery by which this is effected is called a stamping mill, and is provided with a large horizontal axle, furnished with a series of cams arranged in spirals around it. Vertical wooden or iron beams are so attached to large masses of cast-iron, that, when raised by the cams fitted into the axle and corresponding tongues in the lifters, they fall on the mineral beneath them, and thus, by repeated blows, reduce it to a fine powder. The cams are so arranged in the spirals that each lifter shall give three blows during a revolution, and as soon as the first lifter has been released from the cam and begins to fall, the second cam in the series comes in contact with the tongue of the next lifter, and so on until each has in succession struck a blow, when the first lifter is again caught by the first cam belonging to the second system on the axle, when another series of blows is dealt by the several pestles. The lower portion of this arrangement is enclosed in a strong wooden trough or "cofer," in which are openings, into which are fitted gratings made by punching holes into thin pieces of sheet iron. By means of a launder a small stream of water is made to flow continuously into the cofer, and therefore whenever fragments are sufficiently reduced in size to allow them to pass through the gratings, they are carried off by the water into pits in which they are deposited by subsidence. The weight of the pestles usually varies from three to four hundred pounds each, and the number of blows per minute given by each lifter may be from fifty to seventy. The bottom of the cofer is either formed of a large block of cast iron, or of a consolidated mass of hard vein stone, which has become solidified by the constant action of the pestles. The latter arrangement is more commonly employed in this country, but cast-iron beds are much used all over the continent of Europe.

The expense of stamping in this country by steam power, one ton of ordinary stuff, sufficiently fine to admit of the separation of the tin which it contains, may be taken at 1s. 3d., and in some instances tin stuff, containing only about 15 lbs. of merchantable tin in the ton, has been raised and dressed with considerable advantage. Tin ores are usually dressed to a produce of about 70 per cent.; lead ore from 60 to 75 per cent. Copper ores when broken from the vein in Cornwall may be estimated to give an average produce of less than 2 per cent., and are commonly concentrated by mechanical preparation to about 6¾ per cent.

Dressing.—The principles on which is based the concentration of metalliferous ores are exceedingly simple, but the arrangements employed for this purpose are very varied, and are modified in accordance with the nature of the minerals to be operated on. If a number of particles, varying in form, size, and density, be held in suspension in a current of water, or allowed to fall through that medium, they will arrange themselves in accordance with the resistance they experience from that liquid. If their form and size be the same, but they vary in density, they will arrange themselves in the order of their respective specific gravities, the lightest forming the upper, and the heaviest the lower strata, of the series. If, on the contrary, their form and density be the same, but the size different, the larger fragments moving more rapidly than the others, will arrive first at the bottom, and form the lowest stratum of the deposit. This arises from the circumstance that although their volumes increase as the product of their three dimensions, the resistance offered by the fluid increases only as the product of two of those dimensions, and therefore the resistance in the case of the larger fragments is proportionately less. If the granules have the same volume and density, but differ in form, those which expose the least amount of surface will fall most rapidly through the water, and form the lowest layer.

It is therefore evident that the particles of ore to be dressed should be reduced, as nearly as possible, to the same dimensions, in order that they may the more freely subside in accordance with the order of their several specific gravities. Each of the fragments operated on must evidently belong to one of the three following classes:—

The first class will consist of the mineral sought, without any admixture of earthy matter. The second will comprehend the fragments which are made up of a mixture of ore and earthy substances; whilst the third will be composed entirely of earthy matter, without any admixture of ore. By a perfectly successful washing, these three classes would be entirely separated from each other, but in practice this degree of perfection can never be wholly obtained, although the results very closely approximate to the theoretical deductions.

The coarser fragments of ore, which have passed through the crusher, are generally concentrated by jigging, whilst the finer, and those that have been reduced by the stamping-mill, are enriched by washing in currents of water, varying in their force according to the nature of the ore and the minuteness of its state of division.

The methods employed for washing the reduced ores differ not only with the nature of the minerals, but also according to the locality in which the mines may be situated, and I shall therefore confine my observations on this subject to a description of some apparatus which we have recently erected, for the washing of lead ores, at a mine producing large quantities of argentiferous galena, associated with carbonate of iron. I would, however, remark that the chief distinction between ancient and modern ore-dressing consists in the circumstances that, whilst in the former the mineral to be treated was subjected, at intermittent periods, to numerous successive operations, it is in the latter so manipulated that the particles are never allowed to deposit themselves, but the operations are continuously carried on until clean ore is obtained on the one hand, whilst the waste is separated on the other.

The ores, on passing through the rolls, fall into a circular sifter which separates the finer particles from the coarser, these being returned by the raff wheel to be again crushed by the rollers. The ore which has been thus sufficiently reduced in size, and has passed through the rotating sieve, is carried by a stream of water into a second rotating apparatus, formed of perforated sheet iron, by means of which the sand and slimes are removed and washed into the buckets of a small water-wheel, whilst the coarser particles escape by the open end of the cylinder, and are removed to the jigging machines to be further cleansed and separated. The finer particles of ore, and the current of water in which they are suspended on falling into the buckets of the wheel, cause it slowly to revolve, and during its revolution time is allowed for the minerals to settle, in accordance with the size and densities of the particles. The result obtained is, that the heavier sands fall to the bottom of the buckets, whilst the lighter slimes are poured out of the wheel and carried off through suitable launders to the slime pit. The sands remaining in the bottom of the buckets are washed out by means of jets of water obtained by a pressure of about 15 feet in height, admitted behind the centre, and are thus carried off to round buddles, where their concentration is further effected. The tails of these buddles are thrown away, as being of no value; the middles are rebuddled in the same machine; and the heads, after being subjected to washing in a hand buddle, are passed to the dolly-tub, and from thence carried to the smelting house. The slime pit is in the form of an inverted cone, the slimes being admitted at one of its sides by means of a divided head-board, whilst an aperture in the opposite direction admits of the escape of the water and refuse matters held in suspension. As the water passes very slowly through this arrangement, all the more valuable portions of the slime are deposited at the bottom, and are continuously let off by means of a plug valve, over the surface, either of Brunton's cloths or of sleeping tables. The conical slime pit and slime separator were first introduced by Captain Isaac Richards, of the Devon Consols Mines.

The round buddle consists of a conical floor, from 18 to 20 feet in diameter, over which the sands are distributed by means of a launder emptying itself through a revolving funnel supported by a central cone of hard wood or cast-iron. This apparatus is furnished with arms carrying long brushes, which are constantly drawn over the surface of the deposit, and assist in carrying the lighter particles to the outer edge of the circle.

Conclusion.

Although the metalliferous productions of this country annually amount to at least £35,000,000, and the prosperity of Great Britain is in no small degree dependent on her mineral resources, it must be admitted that, even when most judiciously and skillfully conducted, mining operations are more or less hazardous and uncertain in their results. When taken in the aggregate, however, there can be no doubt but that this industry is highly remunerative. It is a common saying, that "all is dark before the pick's point;" and hence, since the miner is unable to see what lies before him, he is not unfrequently, however cautiously and judiciously he may have proceeded, disappointed in his anticipations of profit, and finds, after incurring a large expenditure of both time and money, that his judgment has been at fault, and that his expenditure has been unremunerative. If, however, we take the average return made by well-selected and judiciously-managed undertakings, we shall find that it amounts to from 12 to 14 per cent. on the market value of the property, and if to this be added the increased value of the mines themselves, this amount will be very materially increased.

The mining engineer should not only be well acquainted with the principal facts of geology, mineralogy, and chemistry, but, above all, should possess extensive experience in his profession, and be acquainted with all the details of mining operations, and consequently should have received a sound scientific education, and have had long and practical experience. The management of the mines of this country has usually been confided to individuals who, by their industry and intelligence, have raised themselves from the ranks of the working miner to the position of mining captain, and who, therefore, possess a far larger amount of practical knowledge than of theoretical acquaintance with their business. Although it cannot be denied that experience is far preferable to theoretical knowledge, it will nevertheless be admitted that the two combined will be found more advantageous than either taken separately, and that a sound education is, in all cases, a good foundation on which the superstructure of experience may be subsequently erected.

When but one alone of these qualifications is attainable, there can be no doubt but that the practical man is to be infinitely preferred to the theoretical, but as a knowledge of facts deduced from the observations of others materially facilitates the acquisition of fresh knowledge from our own experience, it is to be hoped that the mining community of this country will not fail to avail itself of the advantages to be derived from the school in Jermyn-street, and that, on the other hand, the students on leaving that establishment will not consider that theory alone, or any mere course of elementary study can make them miners.

As I have before remarked, mining, when most judiciously conducted, is, to some extent, a speculative occupation, but when, on the contrary, the management of mining undertakings is confided to inexperienced and incompetent persons, the result becomes a certainty, and total failure is the consequence.

DISCUSSION.

Mr. C. H. Smith wished to ask Mr. Phillips whether, in his opinion, in the operation of blasting rocks, benefit would not be derived from having the cavity at the bottom of the bore-hole of larger dimensions than the cylindrical hole itself, inasmuch as he apprehended in a hole of equal dimensions throughout, there was a tendency to the blowing out of the gunpowder (much in the same way as in a gun barrel), instead of its having the rending effect desirable in the operation of blasting rock for mining purposes.

Mr. Phillips did not conceive that any practical benefit would result from having the cavity at the extremity of the bore-hole bell-shaped, to effect which several inventions had been introduced. Under the present system the blasting was carried on by the miner with rapidity and efficiency. No doubt, however, the proposed modification would be useful if it could be effected with the same economy as the ordinary method, and with no greater danger of the tool being broken in the cavity. His impression was, that unless something was introduced better than had been hitherto invented, it was practically useless to make any attempt of the kind described by Mr. Smith. The greatest improvement that had been introduced in rock blasting was the substitution of cast-steel for the ordinary iron borers tipped with steel, and much less wear of the tools was caused.

Mr. Smith entered into some details of experiments in rock blasting, undertaken at the suggestion of a committee of this Society some years since. A block of stone being provided, a hole of one and a half-inch diameter, was cut straight into the heart of the stone, and at the bottom a cavity of from three to four inches in diameter was worked out in a very short time, which formed a chamber for the powder; and under such a plan he apprehended that the shock of the discharge would be more effective than in the case of a mere cylindrical hole, which offered less resistance. Mr. Smith added, that the material on which the experiment was tried was Portland stone.

Mr. Varley said he had witnessed the experiments referred to by the last speaker, and he considered the results highly satisfactory. He described the means by which the cavity was formed at the bottom of the bore-hole. A cast-iron ball was introduced, which served to divert the tool from the cylindrical course, and by working round the ball the cavity was formed with considerable facility. This, of course, had reference to borings in a downward direction, but he thought the same operation might be effected in upward borings, by placing the iron ball upon a rod, or supporting it at the top of the bore by means of a spring.

Mr. Pearsall inquired whether gun-cotton had been used to any extent for blasting purposes.

Mr. Phillips replied that, as far as British mining was concerned, he could not speak as to any attempts to use it. It was objectionable on account of its liability to explode from concussion, and to be injured by damp. Experiments with gun-cotton had been made in the mines in Saxony, but it was abandoned in favour of gunpowder, which the miners found to be safer and more efficacious.

Professor Tennant could hardly agree with Mr. Phillips as to the average profit returned from investments in mines, and he considered that from 12 to 14 per cent. was placing it at too high a figure. With regard to the elementary education of the miner in the matters incident to his pursuits, he looked upon that as a question of national importance. Attempts had been made to establish schools for instruction in the mining districts of England, but, up to the present time, those attempts had not been successful. The late Sir Charles Lemon had offered the munificent sum of £10,000 towards the establishment of mining schools in the heart of the mining districts, but it was not responded to by the persons in those districts most interested in the matter. Other attempts to establish schools had been made, but he feared they were languishing for want of proper support. If the mine owners of the country were properly alive to their own interests, they would certainly forward these schools in every way in their power; for, it was well known that, in every description of industrial pursuit, the intelligent workman was always the best workman. He contended that persons destined for mining pursuits ought to receive elementary instruction in chemistry, mineralogy, and geology, which would make them more fitted for their occupation than if they simply relied upon the practical knowledge they might gain by experience. He was astonished to find the difference in point of education between the miners of England and those in many parts of the Continent. He had made inquiries of working miners on the Continent as to the nature of the material they were at work upon, and those inquiries had been answered in a way that he had failed to meet with even from mining captains in England. In point, however, of perseverance and industry, he would place the English miner as high as any of his class in the world. With reference to mining speculation, he was frequently in the habit of meeting persons who asked his advice as to how they were to act in matters of this kind, they having been induced to invest their money, solely from hearing of the enormous profits made in other quarters, and having met with bitter disappointment.

Mr. Ninnis said, with reference to blasting, that he did not see any practical advantage to be derived from an enlarged aperture at the end of the bore, inasmuch as under the plan generally in use, the cavity was sufficiently large to admit of the necessary quantity of powder being placed in it. Such a plan as that suggested, he thought, would be more applicable to open quarries than to underground operations. The author of the paper had pointed out, in a very lucid manner, the advantages of properly-arranged machinery in the economical working of mines, as well as the improvements which had been introduced during the last 50 or 60 years. Within his own recollection the crushing mill was first introduced into the west of England, and consisted of rollers of 12 inches diameter worked by a water-wheel with a small sieve placed underneath them to receive the crushed material. The ore on passing through the sieve was taken away in barrows, and washed after the most simple fashion. Previous to that the ore was broken up by women, the operation being called "bucking," but the introduction of the roller-crushing machine was considered a great improvement. In the machine, the drawing of which was exhibited, the contrivances were very admirable, and the object of economy in working appeared to be fully attained. The round buddle exhibited was also a great improvement upon the old plan of "buddling," and was likely to be very useful. With regard to the value of mining property generally, he did not go to the extent of Professor Tennant in considering it an undesirable investment. His own experience through life had been that mining adventures, entered into with judgment and carried on with honesty, were a satisfactory mode of employing capital. He contended that mining operations ought to be carried on upon the system of underwriting. It capitalists were guided solely by the prices quoted in the market, and by the representations of interested parties, the probability was that they would, in the end, find themselves considerable losers by their speculation. At the same time, he thought it was not proper to charge upon legitimate mining adventures the result which had followed a reckless system of gambling in such matters.

Mr. Thomas Scott considered it essential that education in the elementary sciences connected with mining should be imparted to those who were engaged in that pursuit, in which respect he believed they were very deficient at the present time. In his intercourse with mining captains in England and in Ireland, but more especially in the latter, he found that such professional education as they had acquired had been for the most part matter of chance. Allusion had been made to the unsuccessful attempts to establish schools of mining in the mining districts. The result was, that they had an illiterate class of workmen, and an educated miner was the exception to the general rule. With regard to the profitable nature or otherwise of investments in mining, it was to be remarked that in too many cases adventures were got up for speculative purposes. A company was formed and shares were issued; the promoters always taking care to reserve a large slice to themselves. Calls were made, a captain was engaged, and operations were commenced. It was pretty well known that engineers were not wanting who could furnish glowing reports of the supposed capabilities of a mine. Call after call having been made upon the shares, it would become necessary that there should be some show for the money, and in such case it might be, that, yielding to the pressure from without, the captain would "pick out the eye of the mine," as it was called; or, in other words, not work the lode in a legitimate manner, but only for the purpose of sending some amount of ore into the market. That being done, an outcry was got up as to the yield of the mine, and, thereupon, fresh shares would be issued, and further calls made upon the hapless shareholders, and in that way enormous sums of money had been lost. He submitted that, whilst it was desirable to have the workmen better educated, they also wanted honesty on the part of those who managed these undertakings.

Mr. Phillips fully subscribed to the view expressed, that to improve the education of miners in England would be to improve their position in life. In reply to what had fallen from Professor Tennant, with regard to the superior education of the miners on the Continent, he (Mr. Phillips) would put in a plea for the English miner. He had had the management of one of the largest mines in Westphalia, in which between 300 and 400 German miners were employed; but when a shaft had to be sunk in hard ground, the German workmen were unable to do it, and the work was contracted for by English miners at a less price than it could be done for by native workmen, although the German miners earned only 50s. per month, and the English miners £8 per month. It was true that the Germans were better educated as to reading and writing than the English miners, but they had very little knowledge of mining, which arose from this fact, that at one time the Germans would be occupied in farming, at another time in smelting, and when they had any money they would do nothing at all. The English miner was for the most part attached to his calling, and owing to the tribute system, which had obtained almost from time immemorial, it was to his interest to acquire such a knowledge of his business as to know where to get a "pitch" to earn a good living for himself; and when once a family engaged in mining, they remained miners for many generations.

Mr. Ninnis would mention, in illustration of the benefits resulting from a practical education, that he had known cases in which persons had taken a "pitch" at a higher price than was offered by others, simply from their knowledge of the quality of the material they were going to work upon. It could not be said that all the Cornish miners were ignorant men.

Mr. Hyde Clarke differed from Mr. Tennant, as to the relative intelligence of the English and German miners. The facts and statistics in the paper proved the great progress of English mining in this century, which was owing to improvements effected by the intelligence of the mining class Under these circumstances it could not be conceded that the position of the English miner was so bad as had been assumed. With regard to mining education, neither was it to be assumed that the attempts were failures, or that they ought to be abandoned, still less that their want of progress was the fault of the mining interests, when it might be the fault of the system adopted. It had been urged that Sir Charles Lemon's scheme failed, and the mining schools languished, because the mining interests did not contribute the sums required for their support. Now, whom did they call upon to contribute? First, the lord or landlord, few of whom received large incomes, and many very small dues; next, the mining shareholder, who had only a leasehold interest in what had been defined as an uncertain speculation; and thirdly, the working captain and miner, with very small earnings. Under the circumstances, these were the last persons who could be expected to contribute; but, as mining undertakings, however uncertain to those engaged in them, undoubtedly added largely to the resources of the country, so it was for the interest of the community to support the whole expense of mining education, and to give free instruction to the working miner. However small the fees were, they were a heavy tax on the working captain or miner, who had to make what was a great sacrifice to him, the sacrifice of his working time for the purposes of study, and though he would undoubtedly reap a good return from his improved knowledge, the community would no less benefit. So far from the miner being called upon to contribute or make a sacrifice, he should be encouraged, in every way, by studentships and scholarships, freely given, to attend the schools, more particularly in the beginning, when he was not prepared by experience to appreciate what he considered as merely theoretical knowledge.

Professor **TENNANT** wished to add that an attempt was made, in 1804, to establish a school of mining, and a large sum was subscribed under the auspices of Sir John St. Aubyn, in order to establish a School of Mines at the Royal Institution in Albermarle-street. A sufficient sum was not forthcoming, and the subscriptions were returned. He believed a sum of upwards of £4,000 was subscribed. He hoped to see that system carried out upon an extended scale, which would result in the miners being better educated, and, therefore, superior workmen.

The **CHAIRMAN** said it now became his duty to propose a vote of thanks to Mr. Phillips for his able and interesting paper, and in so doing he desired to be permitted to offer a few remarks. The paper with which they had been favoured comprised a very comprehensive *résumé* of the history of mining, and an able description of many of the processes employed in that branch of national industry. It showed what must be considered a very advanced state of mining in this country, as compared with what it was half a century ago. With reference to the remarks of Mr. C. H. Smith, upon the subject of boring holes for blasting purposes, and the idea he had suggested of an enlarged cavity at the end of the bore, he (the Chairman) did not think that, for mining purposes in general, any practical advantages would be gained from carrying out that plan. In the operation of blasting, as at present carried on, the results were almost universally such as the miner desired to effect; the methods used were generally suited to the circumstances of the mine; the operation was conducted with great rapidity, and had the effect, in most cases, of detaching the quantity of rock that was required to be displaced. Knowing as he did the great ingenuity and talent of Mr. C. H. Smith in all matters connected with the cutting of even the hardest rocks, and his extensive knowledge of the quarries throughout the kingdom, there was no one to whose suggestions on such matters he would bestow greater attention. Mr. Phillips had referred to the extreme fluctuation which took place in mining, and this had given rise to observations which really only ended in this—that mining, like all other things, might be conducted with ability or with want of ability; with honesty or with want of honesty; but as the operations were underground, he must say that it gave rise to a great deal of what he might call unwise speculation, resulting, in many cases, in a vast amount of disappointment to the parties who had entered into it. One of the first things to be done, before they could have mining in this country brought to perfection, was to make all those who entered into mining operations tolerably well acquainted with what they were going into. It was all very well to say, that if people only entered into judicious speculations, they would succeed. The difficulty was to ascertain what was a judicious speculation. He had known persons who had invested large sums of money in mining adventures without the least idea of the nature of the mines, the position of veins, the character of the works, or any other conditions of the undertaking. They took shares merely because they heard that other persons had made a great deal of money by such speculations; and, in his own experience, he could confirm the statement of Professor Tennant, as to the many expressions of bitter disappointment that came from persons who had fallen victims to unsuccessful mining adventures, and who, in the recital of their melancholy history, proved that they had been most sadly and egregiously taken in. He was glad to find that Mr. Phillips, in his paper, had referred to, and taken some extracts from, the curious old literature and charters which were in existence in relation to mining. These would be found highly interesting to those occupied in mining pursuits, inasmuch as there was a quaintness and force about the writings of those ancient authors which were useful and suggestive and withal picturesque. Another point of interest in the paper was the subject of the returns made to the Mining Record Office, in Jermyn-street. Those returns were regularly published, and from that source Mr. Phillips had gathered some of the valuable statistics given in the paper. He (the Chairman) felt the more interest in the success of that establishment inasmuch as twenty years ago it was at his office, in Newcastle-upon-Tyne, that a committee first met for the purpose of urging upon the Government the great importance of such records of mining being kept. The result of the memorial then drawn up by that committee was that a small fund was devoted to the desired purpose; this had since been increased, until, at the present time, the Mining Record Office, under the able management of Mr. Robert Hunt, had been brought to a state of great proficiency and usefulness. He thought nothing of that description could be more valuable than the statistics which Mr. Hunt had collected, and which were published every year. He believed in the present year those records would embrace the particulars of stone quarries, as well as those of coal and other mineral products, so that a more accurate view of British mining would now be afforded than the public had ever before had an opportunity of obtaining. Mr. Phillips had also referred to the extreme fluctuation of prices. That was a subject very intimately connected with the progress of mining, and one which was apparently out of the reach of all calculation. So long as uncertainty of price hung over mineral produce, it was impossible that miners could make their calculations with that degree of certainty which was desirable as a basis for long prospective operations. The advantage of machinery, as compared with the system of levels, had been well pointed out by Mr. Phillips, and he fully agreed with him in thinking that wherever mining operations on a large scale were undertaken, a proper arrangement of the shafts and engines was to be preferred to what was formerly thought to be the more economical method of driving what miners called "day levels." Reference had been made to the School of Mines, in connection with the Museum of Practical Geology in Jermyn-street. That Museum was almost entirely got up through the persevering energy of the late Sir Henry de la Beche, and was at the present time most ably and liberally conducted by Sir Roderick Murchison. By means of an active and most efficient staff of officers, instruction was given in the various branches of science connected with mining operations. Lectures were also frequently given to large numbers of such of the working classes as chose to avail themselves of so valuable an opportunity. Mr. Phillips had mentioned a great name connected with engineering and mining—that of Smeaton—some of whose works, in connection with mining in the north of England, were of great extent and importance, and had led to many valuable improvements. The impress of his mind had been given to the character of mining works, and this had an important practical bearing upon the further improvement of such operations. In connection with the water-engine made by Mr. Westgarth, he might mention that he had in his possession a letter written by Smeaton, in which he strongly recommended Mr. Westgarth to the attention of the Society of Arts as a most ingenious and deserving man, showing the estimation in which this Society was held by so eminent a man as Smeaton. The subject of mining altogether was one of much greater importance than it was generally considered to be; for, if they looked at the position they would be in in the absence of coal, they would see that the due consideration and prudent use of it, and indeed of all minerals, as well as the safe and economical working of them, were subjects of the greatest importance. With respect to the quantity of coal yet remaining in this country great variety of opinion had prevailed. He, himself, was not so sanguine as some as to the long duration of the means of profitably working coal in this country, but whatever would tend to the economical development of the mineral resources of those industries which were at the very foundation of all our manufacturing greatness, was of the highest importance in a national point of view. He was sure the meeting would heartily concur in a vote of thanks to Mr. Phillips, for the interesting and instructive communication which he had laid before them.

A vote of thanks was passed to Mr. Phillips.

The Secretary announced that on Wednesday evening next, May 5th, a Paper by Mr. Charles Sanderson, on "Iron: its Commerce, and Application to Staple Manufactures," would be read.

SOUTH KENSINGTON MUSEUM.

During the week ending 24th April, 1858, the visitors have been as follows:—On Monday, Tuesday, and Saturday (free days), 5,221; on Monday and Tuesday (free evenings), 4,842. On the three Students' days (admission to the public 6d.), 1,392; one Students' evening, Wednesday, 188. Total, 11,643.

Home Correspondence.

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THE SMOKE NUISANCE.

Sir,—Smokeless combustion has been long enough an interesting and important subject, both under a sanitary and commercial view, to render no apology necessary for a few lines, in which I would venture to lay before the large body of coal burners by whom your papers are read, a very successful method of reducing the production of smoke to a minimum in coal fire.

The advantage of obtaining this result in the manner described, is enhanced by the fact that it is attended with the greatest economy, the fuel burnt being of the cheapest kind, and one which has become of late rather heavy on the market, on account of the increased consumption of coke and Welsh coal.

The method is simplicity itself, and is as follows:—Assuming the furnace to be of the ordinary construction adapted for steam purposes, and that the fire is already well lighted, level, and clean, and the bars well covered, take, of north country slack (value about nine shillings per ton, delivered), one and a-half hundred weight, wet it with one bucket full of water, and following up the shovels full in rapid succession, put the whole on one part of the fire; the place is immaterial—front, sides, middle, or back—but cover less than half of it, and take care especially of one point, on which the whole depends, viz., that the heap has a black top, and that it is thick enough for no gases to burst through it.

Before the fresh coal has been on this fire many minutes, a rapid discharge of gases will take place from the under side of the fresh coal, which, passing out through the live coal, will burn with an intense flame all round the edges of the heap. The fresh coal will thus part with all the smoke-producing gases, and become thoroughly caked; until this is the case do not touch it, nor even then unless there is a necessity.

Should other parts of the fire burn into holes while this is going on, feed with coke, but no harm will arise should the heap burn ever so hollow.

When the coal is consumed repeat the process, which may be carried on conveniently on both sides of the furnace simultaneously or alternately.

The idea of coking the coal on its own fire is no novelty, but the essential necessity of keeping a black top has never been insisted on, and, consequently, the plan of firing on part only of the fires may fail or succeed according as that point has been attended to.

I have tried this system for some time, with a consumption of ten tons per diem, and have burnt many hundred tons of slack; the quantity of coke used, on account of my chimney being one of the most noticeable in London, having been about one-third of the whole consumption.

I have little doubt that, in many places, with the exception of the time when fresh fires are lighted, the furnaces might be entirely fed with small coal, which is, for this purpose, far preferable to that of rough size.

Small coal as purchaseable at the London wharves has an efficiency, when thus burnt, only three or four per cent. by weight below the best gas coke, value 18s. per ton.

The method described is the perfect opposite of the time-honoured practice of thin and level firing; and, in Cornish boilers, my own practice of firing, with slack on both sides, brings the section of the fire to the form of a crescent.

To impress the essential point, I have called this system "black-top firing."

I am, &c.,
CHARLES GREAR.

London, April 24, 1858.

Proceedings of Institutions.

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Royston.—At the Institute, on Monday and Tuesday, 12th and 13th inst., Dr. J. C. Daniel delivered the first two of his course of four lectures on the "Four Stuarts." The subjects were—James the First and Charles the First, their private lives and characters.

Salford.—The fourth annual report of the Mechanics' Institution states that the success of the Institution, in its educational departments, was never more marked, and that the numbers attending the classes are considerably above those in the preceding year. A greater proportion than heretofore of the members has been of the adult class. The directors tender their thanks to Messrs. Mather and Platt, Oddy Thompson and Co., and Mr. Guest, for the support they have rendered the Institution, by purchasing and presenting tickets of membership to their workmen, and they earnestly recommend other firms to follow so desirable an example. The directors also thank several other gentlemen for liberal donations to the funds of the Institution. Day schools for boys and girls are connected

with the Institution, and the welfare of these schools has continued to engage a large share of the attention of the directors, who have devoted the Lecture-room of the Institution for the boys' day-school, and have converted the Reading-room and a room adjoining into the girls' day-school, thereby effecting a very desirable improvement in the school-accommodation of the Institution. The evening classes have been well attended, and are conducted in an efficient manner. The subjects taught are:—Reading and writing; arithmetic and grammar; book-keeping; mathematics; algebra; mechanical and architectural drawing; French, and German. There has been a marked increase in the numbers attending the majority of these classes for the quarter ending Christmas 1857. The classes for book-keeping and algebra have been opened during the year. The first public examination of the members attending the classes of the various Institutions in connection with the Institutional Association of Lancashire and Cheshire took place in September last, at the Manchester Athenæum, but, in consequence of the limited notice given by the Council of the Association prior to the examination, only four of the members of this Institution were able to become candidates. Three out of the four competitors, however, obtained certificates and prizes. Several donations have been made to the library, and the books have had an average circulation—the class of works most in demand being those of a standard character. The whole number circulated during the year is 2,200.

MEETINGS FOR THE ENSUING WEEK.

Mon. ......Royal Inst., 2. General Monthly Meeting.
Entomological, 8.
Architects, 8. Anniversary.
United Service Inst., 8½. Mr. J. Bourne, "On the Internal Communications of India."
Tues. ......Royal Inst., 3. Mr. J. P. Lacaita, "On the History of Italy during the Middle Ages."
Civil Engineers, 8. I. Discussion on Mr. Hood's Paper "On Railway Stations." II. General Tremenheere, "On the Public Works of the Bengal Presidency."
Pathological, 8.
Photographic, 8.
Wed. ......United Service Inst., 3. Colonel Wifford, "On the Coast Defences of England."
Royal Soc. Lit., 4½.
Society of Arts, 8. Mr. Chas. Sanderson, "On Iron; its Commerce and Application to Staple Manufactures."
Thurs. ...Zoological, 3.
Royal Society Club, 6.
Antiquaries, 8.
Chemical, 8. Dr. Odling, "On Atoms and Equivalents." Adjourned Discussion.
Linnæan, 8. I. Mr. Masters, "On a new species of *Bellevalia* from Mount Ida." II. Mr. Mitten, "On Indian Musci." III. Dr. Mueller, "Contributiones ad Acaciarum Australiæ cognitionem."
Philological, 8.
Royal, 8½.
Fri. ....United Service Inst., 3. Major Griffiths, "On Field Fortification."
Archœological Inst., 4
Royal Inst., 8½. Mr. J. P. Lacaita, "On the late Earthquakes in Southern Italy."
Sat. ....Royal Inst., 3. Dr. Lankester, "On the Vegetable Kingdom in its relations to the life of man."
Medical, 8.

PARLIAMENTARY REPORTS.

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PRINTED SESSIONAL PAPERS.

Parl. No.

Delivered on 15th April, 1858.

173. Army Estimates—Proposed Alterations.
187. Bullion—Return.
43. Bill—Chelsea Hospital and Waterworks Exchange of Land.
East India (Despatch of Troops)—Further Papers.
Australia (Exploring Expedition)—Papers.

Delivered on 16th April, 1858.

177. Army—Return.
185. Spirits—Returns.
188. Trinity College (Dublin)—Return.
194. Sardinian Medals—Paper.
45. Bill—Hainault Forest (Allotment of Commons).
Cape of Good Hope (Kaffir Tribes)—Further Papers.

Delivered 17th and 19th April, 1858.

190. East India (Education in Behar)—Copy of a Letter.
176. Corn—Return.
178. Army (Regimental Establishments)—Return.
181. East India (North West Provinces)—Return.
184. Ship "Ganges," &c.—Return.
193. National Debt—Account.
197. Manhood Suffrage, &c. (Victoria)—Copy of an Act.
200. Committee of Selection—6th Report.
113. Harbour, &c., Bills (16. Mersey Docks and Harbour (New Works, &c.)—Board of Trade Report.
118. Local Acts (24. Trent Navigation; 25. Andover Canal Railway; 26. Tramore Embankment; 27. Clyde Navigation; 28. Victoria Station and Pimlico Railway; 29. Whitehaven Junction Railway; 30. Middlesborough Improvement; 31. Tees Conservancy)—Admiralty Reports.
44. Bill—Juries (Ireland).
46. ———Chancery Amendment.
47. ———Chelsea Hospital (Purchase of Lands).
48. ———Portumna Bridge (Ireland)—(As amended by the Select Committee).
East Indies (Mutinies)—Supplement to Papers (No. 6).

Session (Second), 1857.

310. Sessional Printed Papers—Numerical List and Index.
310 (1). Sessional Printed Papers—Titles and Contents.

Delivered on 20th April, 1858.

164. Game Laws—Abstract of Return.
201 (1). East India (Revenues, &c.)—Return relating to Writerships.
201 (2). East India (Revenues, &c.)—Return relating to Proprietors of East India Stock.
203. Army (Civil Administration)—Return.
Passports—Correspondence.
Customs—2nd Report of Commissioners.

Delivered on 21st April, 1858.

198. Dunfanaghy Union—Correspondence, &c.
199. Coals (Aldershot)—Return.
204. Reformatory Schools—Return.
209. Enlistment of Krewmen—Return.
213. Police Certificates—Return.
113. Harbour, &c., Bills (27. Middlesborough Improvement)—Board of Trade Report.
33. Bill—Cruelty to Animals Act Amendment.

Delivered on 22nd April, 1858.

206. Revised Army Estimates.
207. Army (Officers allowed half-pay with Civil Situations)—Return.
214. Barracks—Return.
216. Railway and Canal Bills—2nd Report from General Committee.

Delivered on 23rd April, 1858.

195. Sandhurst Royal Military Academy—Return.
202. Prince Edward Island—Papers.
210. Army (Sums paid to Relatives of Deceased Officers)—Statement.
113. Harbour, &c., Bills (28. Wallasey Improvement)—Board of Trade Report.
49. Bills—Poor Law Amendment.
51. ——— Registration of County Voters (Scotland).
53. ——— Customs Duties (No. 2).
The "Cagliari" (Fac-simile of the Draft of Sir J. Hudson's Letter)—Further Paper.
The "Cagliari" (Opinions of the Law Officers of the Crown)—Further Correspondence.
East Indies (Mutinies)—Further Papers (No. 7).

Delivered on 24th and 25th April, 1858.

64. Order of the Bath—Returns.
68 (3). Trade and Navigation—Accounts (31st March, 1858).
201 (3). East India (Revenues, &c.)—Accounts of Imports and Exports.
201 (4). East India (Revenues, &c.)—Statement of Tariff on Duties.
201 (5). East India (Revenues, &c.)—Statement of Territories, &c.
201 (6). East India (Revenues, &c.)—Statement of the Number of Natives employed in the Civil Administration.
201 (7). East India—Statement of Lines of Railway, &c.
117. Railway and Canal Bills (96. Limerick and Foynes Railway)—Board of Trade Report.
211. Foot Guards—Return.
215. Bands—Return.
218. Education—Returns.
220. Patriotic Fund—Correspondence.
40. Bills—Roads, &c. (Scotland).
52. ——— Excise Duties.
56. ——— Property Qualification.
50. ——— Reformatory Schools (Ireland).
57. ——— Registration of Partnerships.
60. ——— Franchise Prisons.
61. ——— Durham County Palatine Jurisdiction.

Delivered on 27th April, 1858.

179. East India (Public Debt)—Return.
222. General Board of Health (Orders in Council)—Returns.
223. Board of Health (Expense of Printing, &c.)—Returns.
227. Seamen's Savings Bank—Account.
201. East India (Revenues, &c.)—Returns relating to the Armies of India, &c.
132. Railway Acts—Return.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, April* 23, 1858.]

Dated 16*th February*, 1858.

293. J. Coutts, Willington-lodge, Willington, Newcastle-on-Tyne—An improved paint, pigment, or composition, more particularly adapted for coating the hulls of ships, either iron or wooden, so as to prevent damp, corrosion, or fouling, and apparatus for drying and warming surfaces, and preparing and applying to the same such paint, pigment, or composition.

Dated 24*th March*, 1858.

617. C. Kottula, Liverpool—Imp. in purifying soda leys, whereby they are rendered capable of saponifying all fatty matters or resins used in the manufacture of soap.
618. C. Kottula, Liverpool—Imp. in the manufacture of compact neutral soap.

Dated 3*rd April*, 1858.

704. A. Pelez, 9A, Mortimer-street, Cavendish-square—A new apparatus for deepening rivers and rendering them navigable. (A com.)
714. E. Edwards, Birmingham—An imp. or imps. in the manufacture of glass finger plates for doors and other articles of like manufacture.

Dated 5*th April*, 1858.

720. W. S. Clark, Atlas Works, Upper Park-place, Dorset-square—Imp. in grain and grass harvesting machines, and in the automatic delivery thereof of cut grain. (A com.)
722. J. Smith, Oldham—Imp. in the manufacture of pile fabrics.
724. S. Fox, Stockbridge Works, Deepcar, and J. Chesterman, Sheffield—Imp. in stays or corsets, and in the manufacture of steel employed therein, and applicable to other articles of dress.

Dated 6*th April*, 1858.

726. L. T. Van Elven, Clapham-road—Imp. in apparatuses for raising and lowering weights and bodies.
728. H. Wetherell and G. Gray, Upper Chapman-street—An apparatus for preventing down draughts and currents in chimneys, flues, and shafts.
730. J. Camp, John-street, Tysoe-street, Clerkenwell—An improved construction of expanding portfolio.
732. C. H. Chadburn, Liverpool—Imp. in pressure guages.
734. J. Erckmann, Rue Faubourg St. Honoré, Paris—Imp. in galvanic batteries.
736. B. Blanché, Bordeaux, France—Using Malacca and Manilla cane instead of whalebone.
738. J. Rose, Glasgow—Apparatus for applying heat, cold, moisture, fumes, vapours, and other agents in medicine and surgery. (A com.)

Dated 7*th April*, 1858.

741. A. Casartelli and L. Casartelli, Liverpool—Imp. in pressure and vacuum gauges.
743. W. A. Gilbee, 4, South-street, Finsbury—An improved machine for corking bottles. (A com.)
744. J. Wright, 10, Alfred-place, Newington-causeway, Southwark—Imp. in the mode of treating leather in order to render it waterproof. (A com.)
745. W. Armitage, Farnly Iron Works, and H. Lea, Farnly, near Leeds—Certain imp. in the manufacture of iron.
746. R. Worthy, Albert-street, Regent's-park—An apparatus for preparing medical fomentations.
747. G. W. Baker, Park Farm, Woburn—Improved signal apparatus to be applied to railways.
748. W. Nimmo, Manchester—Imp. in the manufacture of printed woven fabrics.
750. John Doherty, Edinburgh—Imp. in buttons or dress fastenings.
751. C. F. Whitworth, Sheffield—Imp. in signal apparatus for railways.

Dated 8*th April*, 1858.

754. J. Cartwright, Shrewsbury—Improved apparatus for transmitting motive power for driving machinery.
755. G. Davies, 1, Serle-street, Lincoln's-inn—Imp. in the manufacture of wads for ordnance. (A com.)
756. G. E. Taylor, Oatlands, Leeds—Imp. in machinery for raising the pile of cloths.
757. G. Rowland, Brussels—Imp. in the manufacture of artificial whalebone.
758. F. W. Mowbray, Bradford, and J. Broadley, Saltaire—Imp. in means or apparatus employed in weaving.
759. W. Clark, 63, Chancery-lane—A burner for candles. (A com.)
760. T. Greenwood, J. Batley, and J. Dockray, Leeds—Imp. in machinery for carding, opening, straightening, and preparing to be spun, tow and other fibrous materials.
761. T. Roberts and J. Dale, Manchester—Imp. in the production of a substitute for oil used with pigments, and in the preparation of pigments suitable thereto.

Dated 9*th April*, 1858.

763. W. Ager, Rohrsburg, U.S.—An imp. in rice cleaning machinery.
765. W. R. Jackson, Baltimore, U.S.—A self-acting railway break.
767. H. Bayley and J. Greaves, Staleybridge—Imp. applicable to certain machines for spinning and doubling fibrous substances.
769. Hon. W. Talbot, Army and Navy Club, Pall-mall—Imp. in means or apparatus to facilitate the lowering and detaching of boats from ships or vessels, which improvements are also applicable to lowering and disengaging other bodies.

Dated 10*th April*, 1858.

771. R. M. Ordish, 18, Great George-street, Westminster—Imp. in suspension bridges and suspended girder bridges.
773. G. Guyot, Denain, France—Welding broken cast-iron pieces.
775. P. Brun, 1, Rue de Grenelle, St. Honoré, Paris—The application of an improved blowing fan to steady or portable forges, with or without reverberatory furnaces, as well as to ventilation in general. (A com.)
777. S. T. Parmelee, Edinburgh—The manufacture of improved belting for machinery or other purposes.
779. W. G. Armstrong, Newcastle-upon-Tyne—Imp. in the means of firing or igniting explosive projectiles.
781. D. McCrae, Greenock—Imp. in preserving ships' bottoms and other exposed surfaces from fouling and injury or decay.
783. A. Manbré, 10, Rathbone-place, Oxford-street—The manufacture of a colouring matter for colouring spirits, beverages, and other liquids from the sugar of potatoes, known as glucose and syrup "de fecule."
785. A. C. Thibault, Paris—Imp. in the manufacture of paper-hangings, and in the machinery employed therein.

Dated 12*th April*, 1858.

787. S. Bickerton, Oldham—A thermo-pneumatic lubricator for oiling shafts, axles, machinery, &c.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

841. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—A certain medicinal compound for the treatment of epilepsy. (A com.)—17th April, 1858.
842. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—An improved system of portable tents for railway and other purposes. (A com.)—17th April, 1858.
843. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—An improved substitute for the pulverized cotton and wool employed in the manufacture of felted tissues, papers, and other fabrics. (A com.)—17th April, 1858.

WEEKLY LIST OF PATENTS SEALED.

April 23*rd*.

2703. R. Harrild and H. Harrild.
2707. J. Macintosh.
2708. J. Thom & D. McNaught.
2711. Jas. Fairclough, J. Fairclough, and J. Cowan.
2716. J. Ferrabee and C. Whitmore.
2718. W. Clarke.
2721. J. Newall.
2726. H. J. Daniell.
2730. P. A. M. Maury.
2733. G. Shillibeer and G. Giles.
2734. J. Sloper.
2740. John Child and Jos. Child.
2743. R. A. Ronald.
2765. G. B. Galloway.
2768. T. Lowe.
2794. A. C. Sacré.
2801. R. I. C. Dubus.
2811. J. J. Cousins.
2850. A. J. Davis.
2855. S. Webster.
2879. J. Gedge.
2887. E. D. Johnson.
2933. A. V. Newton.
2937. J. Schloss.
2968. F. G. Grice.
2988. J. Summers and D. Wormald.
2997. J. Livesey.
3042. T. W. Willett.
147. A. Bird.
245. R. Carte.
294. W. Armitage.
301. G. Baker and J. E. Baker.
329. W. Thomson.
350. W. Johnston.
422. G. J. Parson & T. Pilgrim.

April 27*th*.

2727. J. Addison.
2741. H. Taylor.
2744. W. Greening.
2746. D. de la C. Gourley.
2748. T. Cook.
2752. E. Smith.
2759. W. Harwood.
2763. S. Knowles.
2774. P. Gabbitass.
2785. J. Apperly and W. Clissold.
181. J. Childs.
359. S. Smith.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

April 19*th*.

880. H. Macé.
886. R. Bright.
913. J. Hunter and G. Hunter.

April 20*th*.

892. W. Hadfield.
921. L. A. Avisse.
946. W. Shears.
1071. J. Herdman.

April 21*st*.

903. J. Whitworth.
923. J. Wallace, junr.

April 23*rd*.

916. M. A. Muir.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
4080	April 22.	Chimney Top	T. Parr	55, Lower Union-street, Torquay.
4081	,, 24.	Corset Fastener	J. Pierre and Co.	82, New Elvet, Durham.
4082	,, 26.	Wrought-iron Window and Frame	Burt and Potts	York-street, Westminster, S.W.